STRUCTURED PRIVATE ADDRESSING AND NAMING
FOR MANAGEMENT OF SERVICE AND NETWORK RESOURCES

RELATED APPLICATION

[0001]   This application claims the benefit of the filing date of United States Provisional

Application, Serial No. 60/507,278, filed September 30, 2003, titled "Structured Addressing for

Optical Service and Network Management Objects," the entirety of which provisional

application is incorporated by reference herein.

FIELD OF THE INVENTION

[0002]   The invention relates generally to communications networks. More particularly, the

invention relates to a system and method of managing service resources and network resources in

private telecommunication networks using structured private addressing and common naming to

identify logical and physical resources in such networks.

BACKGROUND

[0003]   The communications industry uses a variety of numbering schemes for identifying

and inventorying network resources. Current inventory management systems use Common

Language Equipment Identification or CLEI codes for precisely identifying form, fit, and

function of specific equipment items used in circuit-switched and packet-switched, wire line and

wireless, Public Switched Telephone Network or PSTN, Digital Private Line (PL) networking,

Optical networking, Digital Subscriber Line, Frame Relay, Asynchronous Transport Mode

(ATM), Internet Protocol and Multiprotocol Label Switching (IP/MPLS) technologies. Common

Language Location Identification or CLLI codes identify and describe network sites, network

support sites, and locations of offices and equipment. Another numbering scheme, Network

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Service Access Protocol (NSAP), identifies network endpoints used in Opens Systems

Interconnection (OSI) networking.

[0004]   As an example of an implementation of a present-day numbering scheme, FIG. 1

shows a network 2 having a plurality of private local-area networks or LANs 10 in

communication with each other over a service provider network 12. To support service traffic

from the LANs 10, the service provider (SP) network 12 includes edge-service network elements

(NEs) 14, 14' and a plurality of core NEs 18, together managed as an SP private network. Each

edge-service NE 14, 14' has a tributary interface 20 in communication with one of the LANs and

a line interface 22 for communicating over the network 12. The core NEs 18 also have line

interfaces 24 for carrying service traffic between the LANs 10. Various numbering codes are

used to identify the NEs 14, 14', 18, interfaces 20, 22, 24, and circuits in the service provider

network 12. A Network Element Identifier (NEID or TID) identifies each NE 14, 18 and an NE

interface ID (IFID or AID) identifies a port card in the NE. The TIDs and AIDs are physical

identifiers, i.e., the identifying codes are recorded at the NE or on each port card. Other physical

identifiers include CLLI codes for NEs and CLEI codes for port cards. A network Operations

Systems Support (OSS) 28 maintains a master data base of accounting and inventory records to

track the physical network resources (e.g., NEs, equipment, and facilities) and logical service and

network resources (e.g., customers, circuits, virtual circuits, trunks or virtual trunks) in the SP

network 12. The network OSS 28 performs a variety of management functions, including

accounting / inventory, fault management, configuration or provisioning management,

performance monitoring, and security. Responsibility for the proper operation of the SP network

12 in support of the service resides with the network OSS 28.

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[0005]   During a typical flow of operations, a customer purchases a service from a service provider, resulting in a service order. A service Operations Systems Support (OSS) 26, managing the relationship with the customer, typically in accordance with a service level agreement (SLA), handles the order fulfillment, service assurance, and billing for the service. The service OSS 26 associates the customer information (e.g., customer address, contact information and service specific information) with the master database of the network OSS 28.

[0006]   Upon receiving a service order from the service OSS 26, the network OSS 28 examines the SP resources at the various locations to identify the SP network resources that will support the service (e.g., from location A to location B). The network OSS 28 uses the CLLI to identify equipment at these locations and the CLEI to identify the physical equipment and port cards that will provide the circuit, virtual circuit, or path that will carry the service traffic. The network OSS 28 also searches its database for equipment at those location sites and at intermediate sites. Operations personnel then designs a circuit, virtual circuit, or path to transport the service traffic, assigns a logical circuit identifier (CID) to the circuit, virtual circuit, or path using a Common Language Circuit Identifier or CLCI code, and builds (i.e., configures) the circuit, virtual circuit or path. The circuit ID at the OSS level is associated with each NE (identified by a TID) and with each port card (AID) in the circuit. In traditional networks, the logical identifiers (CID) are maintained by the network OSS 28 only.

[0007]   The network and service OSSs often employ these numbering or coding schemes to inventory and identify network equipment supporting a service. For example, occasionally conditions arise in the network 2 that can disrupt or degrade the service. Alarms reporting the problem pass to the network OSS 28 from a network element detecting the network condition.

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When passing an alarm or report to the network OSS 28, the network element reports the TID,

AID, and channel information. The network OSS 28 forwards the circuit information and

facility information to the service OSS 26. The service OSS 26 analyzes this information in an

attempt to determine whether the network condition is affecting its service and whether such an

effect is impacting the SLA.

[0008]   Typically, however, the circuit and facility information passed to the service OSS 26

is insufficient to determine directly those services affected by the network condition. Generally,

correlating these codes to services is onerous and requires coordination between the service OSS

26 and the network OSS 28. Either a proprietary translation method is needed to find common

names associated with the numbered resources or no common naming features are used at all.

Consequently, the service OSS 26 has difficulties readily determining whether its service is

operating properly from the information provided to it from the network OSS 28. Thus, there is

a need for a system and method for identifying service and management resources more

efficiently than current numbering codes.

SUMMARY

[0009]   In one aspect, the invention features a method for identifying resources associated

with a communications network. A structured address format is defined having a plurality of

address segments. Each address segment of the format is associated generally with one or more

properties of a managed resource of the private communications network. A structured address

constructed according to the structured address format is assigned to the managed resource.

Each address segment of the assigned structured address has a value that conveys information

about one or more properties of the managed resource.

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[00010] In another aspect, the invention features n inventory system for managing resources of a private communications network. The inventory system comprises a structured address format having a plurality of address segments. Each address segment is associated generally with one or more properties of a managed resource of the private communications network. The inventory system also includes means for assigning to the managed resource a structured address constructed according to the structured address format. Each address segment of the assigned structured address has a value that conveys information about one or more properties of the managed resource.

[00011] In yet another aspect, the invention features an operations support system comprising means for defining a structured address format having a plurality of address segments. Each address segment is associated generally with one or more properties of a managed resource of a private communications network. The operations support system also includes means for assigning to the managed resource a structured address constructed according to the structured address format. Each address segment of the assigned structured address has a value that conveys information about one or more properties of the managed resource.

BRIEF DESCRIPTION OF THE DRAWINGS

[00012] The above and further advantages of this invention may be better understood by referring to the following description in conjunction with the accompanying drawings, in which like numerals indicate like structural elements and features in various figures. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the principles of the invention.

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[00013]   FIG. 1 is a diagram of an embodiment of a network using present-day numbering codes to identify network resources.

[00014]   FIG 2A is a diagram of an embodiment of a network using structured addressing of the invention to inventory and identify service and network resources.

[00015]   FIG 2B is a diagram of an embodiment of a network spanning multiple sub-networks, for example, Local Area Transport Areas (LATAs), and using structured addresses of the invention to associate a service and a path identifier with multiple circuit identifiers.

[00016]   FIG. 3 is a diagram of an embodiment of a structured address format of the present invention for defining structured addresses that identify service resources.

[00017]   FIG. 4A and FIG. 4B are diagrams of examples of associations between character positions of the structured address format of FIG. 3 and properties of a service resource.

[00018]   FIG. 5 is a diagram of an embodiment of a structured address format for defining structured addresses that identify network resources.

[00019]   FIG. 6 is a diagram of an example of a networking layer 2 structured address used to identify a service resource.

[00020]   FIG. 7 is a diagram of an example of a networking layer 2 structured address used to identify a network resource.

DETAILED DESCRIPTION

[00021]   The present invention provides a naming and addressing mechanism that helps service and network Operations Support Systems (OSS) manage their specific services, facilities,

and equipment. In brief overview, anything associated with a service or network can be given a private common name and a private structured address, described below. The service and network OSSs can each independently of the other assign names to logical and physical, service and network resources (hereafter referred to generally as managed resources). Managed resources include, but are not limited to, network elements, paths, connections, circuits, tunnels, services, port cards, trunks, office locations, network alarms, network performance, work orders, reports and general network OAM&P (Operations, Administration, Maintenance, and Provisioning). Generally, the service OSS assigns names to service resources and the network OSS to network resources. The assigned names are primarily alphanumeric and descriptive of the named resource so that OSS personnel can readily identify the named resource from the given name. Because alphanumeric names are more readily understood than numbering codes, the naming of managed resources facilitates the performance of operational processes and of customer care. These assigned names are hereafter referred to as common names.

[00022]   Also associated with each managed resource is an address (or a code). Although referred to throughout this description as addresses, such addresses are not used for traffic routing purposes. The association of the address to the managed resource can be physical (i.e., the appropriate OSS records the address on the resource) or logical (i.e., the appropriate OSS maintains a document, table, or database cross-referencing the address with the resource). Preferably, the format of the address is structured; that is, each address is comprised of segments having one or more character positions, and a value given a particular address segment conveys information about a property or characteristic of the managed resource associated with that address. This structured format facilitates searching and mapping to assigned names. Given a

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name, the service OSS or network OSS can translate the name to a corresponding address; or

given an address, translate to a name.

[00023]   FIG. 2A shows an embodiment of a network 100 employing managed resource

naming and addressing of the invention. The network 100 includes a plurality of LANs 10 in

communication with each other over a service provider (SP) private network 102. As used

herein, a private network means a network comprised of circuits known exclusively to and for

the exclusive use of an organization or group of affiliated organizations. In one embodiment, the

SP network 102 is a connectionless network (e.g., a local area network (LAN), metro-area

network (MAN), or wide-area network (WAN). Examples of connectionless networks include

IP networks, such as the Internet, private LANs and SANs, and private LAN enterprises. In

another embodiment, the SP network 102 is a connection-oriented network, such as Multi-

Protocol Label Switching (MPLS), Synchronous Optical Network (SONET), Synchronous

Digital Hierarchy (SDH), or Optical Transport Network (OTN). In yet other embodiments, the

SP network is a network of networks (i.e., of connectionless or circuit-oriented LANs, MANs,

WANs, or combinations thereof), supported by one or more service providers (or carriers).

[00024]   The SP network 102 has a variety of network resources, including a near-end edge-

service node or network element (NE) 104 in communication with a far-end edge-service

network element NE 106 through a plurality of intermediate or core network elements NE 108-1,

108-2, and 108-3 (generally, core NE 108). Transmission of service traffic among the NEs 104,

106, 108 is over a transport facility 110. In one embodiment, the transport facility 110 is an

optical transport facility based on a synchronous data transmission standard such as SONET.

Other types of transport facilities than optical transport can be used, such as wired or wireless

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transport, without departing from the principles of the invention. Each edge-service NE 104, 106 includes a tributary interface 112 and a line interface 114 (which are not shown for NE 106). The core NEs 108 include line interfaces 118 (shown in representative core NE 108-2).

[00025] In the embodiment shown, the SP network 102 employs conventional coding mechanisms described in FIG. 1 for identifying the NEs 104, 106, 108 and interfaces 112, 114, 118 (e.g., TIDs, AIDs, CLEIs, and CLLIs). As a supplement or alternative to these conventional coding mechanisms, the SP network 102 employs the addressing mechanism of the present invention. Here, the addressing mechanism is embodied in a service identifier (SID) and a path identifier (PID), collectively denoted by reference numeral 116 at the near-end NE 104 and by reference numeral 120 at the core NE 108. Such service and path identifiers illustrate addressing for two examples of managed resources; namely, the service being supported by the SP network 102 and the path taken by the service traffic through the SP network 102. In one embodiment, the SID and PID are recorded at each of the edge-service NEs 104, 106 and at the core NE 108-2. Typically, the SID and PID are recorded at the edge-service NEs 104, 106 when the service is provisioned and the core NEs 108 learn these addresses from the contents of the service traffic passing therethrough.

[00026] In accordance with the invention, a service OSS 124 generates and assigns the SID in the network OSS 128 inventory and provisions the SID at the near-end NE 104 upon configuring or commissioning the service to be transported over the SP's private network 102. The service OSS 124 also assigns a common name to the SID (e.g., "ACME/OttawaBoston /E-line/VPN"). A database or records 130 maintained by the service OSS 124 associates the assigned common name to the SID.

[00027]   SIDs can be used to augment or extend the capabilities of traditional inventory

systems, for example, by associating SIDs with one or more traditional CIDs (CLCI).

Accordingly, SIDs can be added to the Network OSS records or databases, assigned to CIDs

within a traditional inventory system, such as the Trunks Integrated Record Keeping System

(TIRKS), or both.

[00028]   In some instances, a SID can be used to associate two or more different CIDs. FIG.

2B illustrates such an example for a service that traverses multiple distinct sub-networks 150,

150', 150'' (generally, sub-network 150) over a single path. Local Access Transport Areas or

LATAs are examples of the sub-networks 150. Each sub-network 150 is administered as a

separate private network and employs a separate inventory system 154, 154', and 154''

(generally, inventory system 154). An example of such an inventory system is TIRKS. For each

sub-network 150, a different CID is associated with the service. Each different CID corresponds

to a different section of the full path. Here, the different CIDs are identified as Circuit ID A,

Circuit ID B, and Circuit ID C.

[00029]   An OSS 160 oversees the operation of the service from end to end between the NEs

164, 164' and has access to each of the inventory systems 154. Into each of these inventory

systems 154 the OSS 160 stores the SID, PID, and the different CIDs associated with the service.

Accordingly, in this example, a single SID and a single PID are each associated with three

different CIDs. Further, in these inventory systems, the SID and PID can each be used to

associate the different CIDs with each other.

[00030]   As another example, a single SID can be assigned and associated with two or more

different CIDs when a single data service requires two or more separate circuits to operate. For

example, consider an Ethernet Private Line (EPL) service transported using Virtual

Concatenation (VCAT) with 3xSTS-n, DDS – 56K and Error Correction via 2x DS0. In this

example, illustrated by the third row of TABLE 1 below, a single service ID is associated with

two different path IDs (path ID A and path ID B). Each path ID corresponds to one of the

separate circuits and is associated with a different one of the CIDs. TABLE 1 also illustrates

other examples of 1:N:N relationships among SIDs, PIDs, and CIDs for various types of services

in four different types of networks: 1) Digital networks; 2) Optical networks; 3) Ethernet

networks; and 4) IP/MPLS networks. The examples are merely illustrative, and are not intended

to be representative of all possible associations among SIDs, PIDs, and CIDs.

TABLE 1:

Service ID: Path ID: Circuit ID Associations	1:N:N	Digital	Optical	Ethernet	IP/MPLS
Service ID → Path ID → Circuit ID	1:1:1	DS0 PL DS1 PL DS3 PL	OC-n PL EPL (STS-nc)	EVC	LSP
→ Circuit ID A Service ID → Path ID → Circuit ID B → Circuit ID A	1:1:3	Cross-LATA Metro/ National	Cross-LATA Metro/ National	Metro/ National/ Global	Metro/ National/ Global
Service ID →Path ID A→ Circuit ID A →Path ID B→ Circuit ID B	1:2:2	DDS Inverse Mux	OC-n PL (N x STS) EPL (STS-nvc)	Protected EVC	Protected LSP

[00031]   Similarly, a network OSS 122 can generate and store the PID at the near-end NE 104

upon designing the circuit, virtual circuit, path, tunnel, or connection (hereafter generally

referred to as circuit) to be taken by the service traffic, add the PID to the inventory system (e.g.,

TIRKS), and associate the PID with a common name. The network OSS 122 maintains records

that include the PID and, optionally, the service ID. For example, consider that the network OSS

122 maintains a record 134 of a circuit (referred to, for example, as circuit 543) that includes a plurality of NEs (numbered 90, 128, and 495). The PID appears under the heading for the circuit 543 and for each of these NEs. Optionally, the SID appears under the heading for each NE, too. In this example, the addresses of the invention (here, e.g., the SID and PID) are supplemental to the numbering systems of conventional systems; that is, the PID and SID are added to the conventional inventory formats (e.g., Telecordia Technologies formats, such as CLCI (common language circuit identifier) and CLFI (common language facility identifier), and conventional TL-1 structures, such as TID and AID), or to other numbering codes of traditional OSS systems. The addition of SIDs (and PIDs) to traditional inventory systems enables the use of conventional searching techniques to find common names associated with logical and physical network and service resources.

[00032] When, in the operation of the SP network 102, any of the NEs 104, 106, 108 produce a report (e.g., performance monitor, alarm), that report can include one or both of the SID and the PID. For example, service reports containing performance metrics and availability of service metrics also contain the SID for the measured service and, optionally, the PID of the path supporting that service. Network or path reports raising alarms or reporting performance and availability metrics for the path contain the PID of the path, and, optionally, the SID of each service transported over the path. These network or path reports can also include the traditional TID/AID/Channel and Port ID identifiers. Alternatively, the network OSS 122, service OSS 124, or both can dynamically access one of the NEs 104, 106, 108 to obtain the PID and SID information recorded thereat. From the PID and the SID, the network OSS 122 or service OSS 124 can access its own locally kept records 134, 130 to readily determine the common names of the service and network resources described by the reports.

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[00033]   Addresses associated with managed resources are preferably structured addresses, as described below. As used herein, structured means that the individual segments that make up an address each independently convey meaning about the managed resource. Address segments include one or more characters. For example, the position and value of each digit or character in an address segment has significance, i.e., to convey certain information about a property of the managed resource. Accordingly, the characters of a structured address individually and collectively convey information.

[00034]   The format of a structured address of the invention can follow the format of any conventional or proprietary physical or logical address. Examples of such formats include, but are not limited to, NSAP, Transport Network Address (TNA), Q-tags, CLEI codes, Media Access Control (MAC) addresses, 32-bit MPLS labels, IPv4 addresses, and IPv6 addresses. In a preferred embodiment, structured addresses of the invention have a similar format as that of IPv4 addresses (i.e., four-byte dotted decimal notation). Unlike IPv4 addresses, which are used to identify host interfaces for the purpose of routing traffic through the Internet, the four-byte embodiment of a structured address of the invention operates to identify properties or characteristics of managed resources in a communications network.

[00035]   An advantage of structuring addresses similarly to the IPv4 address format is the abundance of currently available tools and tool sets for performing address-to-name and name-to-address translation. Specifically, the standard IP domain name system (DNS), for example, which was developed to translate between domain names and IP addresses and to route Internet traffic, can be used with the present invention to perform the address to common name translations. An exemplary implementation of the DNS, in general, entails the use of two large

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tables: one table translates from addresses to common names; the other translates from common

names to addresses. The one table has a first column containing four-byte integers representing

addresses and a second column containing DNS strings representing common names. The other

table has a first column containing DNS strings representing common names and a second

column containing four-byte integers representing addresses. Standard search engines can also

be used with the present invention, thus providing inventory search features superior to

traditional inventory system

[00036]   Structured addresses, in one embodiment, are also private in that the each service

OSS and each network OSS generates, distributes, and maintains its own set of addresses (i.e.,

each possesses its own private addressing system). Generally, each OSS 122, 124 can employ its

full range of addresses (as that OSS defines that address range), and associate such addresses

with managed resources independently of the address associations made by other organizations;

to take advantage, however, of existing DNS tools, those embodiments of structured addresses

adhering to the four-byte IPv4 address format are limited to the address range conventionally

allocated to IPv4 addresses (i.e., each byte of the four-byte structured address is within the range

of 0 to 255, inclusive). Within each OSS, each address in the set of addresses is unique, but the

addresses of one OSS need not be unique from those of another OSS (or from one organization

or entity to another organization or entity). Each network and service OSS 122, 124 can

maintain its own DNS service and its own naming conventions and databases and perform its

own searches and inventorying. Provided different OSSs employ the same structured format for

its addresses, currently available tools facilitate the merging of distinct address systems, thus

simplifying the combining of separately developed inventory systems that employ the naming

and addressing mechanism of the invention. An example of a tool for translating addresses

defined according to one structured address format into addresses constructed according a second

structured address format is the Network Address Translation (NAT) tool. Accordingly, OSSs

can use standard NAT tools to translate between different service resource databases and

between different network resource databases.

[00037]   Addresses (i.e., structured, private, or both) can be assigned to a wide variety of

physical managed resources and logical managed resources at different levels of networking,

e.g., at the network element (NE) level, at an Element Management System (EMS) level, at the

OSS level or at any combination thereof. Addresses can also be implemented at different layers

of networking, e.g., at layer 1 (physical layer), at layer 2 (data link layer, including MAC sub-

layer), and at layer 3 (networking layer), or combinations thereof. For example, addresses can be

associated with specific named, managed resources, such as optical User Network Interface

(UNI) ports (UNI ID), specific service interfaces associated with customer interfaces, specific

service paths or end-to-end circuits (i.e., Circuit ID, Port ID), services (Service ID or SID),

equipment such as network elements (NE), port cards, office locations (i.e., NE ID, Card ID,

Location ID), and paths, connections and/or tunnels (Path ID, Connection ID, Label Switched

Path (LSP ID), Layer 2 Tunneling Protocol (L2TP ID)). Common names and addresses can also

be associated with network alarms, network performance, network work orders, reports and

general network OAM&P.

[00038]   FIG. 3 shows an exemplary embodiment of a structured address format 200 having a

plurality of digit or character positions divided into address segments 204-1, 204-2, 204-3

(generally, address segment 204) separated by decimal points. Each character position is

associated generally with a property of a managed resource. The managed resource in this

example is a service, and properties of this service include type of service, class of service, service zone, and numbered instance of the service. Addresses constructed according to this structured address format 200 have character positions associated with each of these properties of the managed resource. For instance, the address segment 204-1 has two character positions for identifying a service type 208, address segment 204-2 has one character position for identifying a service class 212 and another character position for identifying a service zone, or, alternatively, a service attribute, and address segment 204-3 has a plurality of character positions for identifying particular instances of services. The structured address format 200 is merely exemplary; a structured address of the invention can have, for example, fewer or more address segments, address segments with different associated meanings, a different hierarchical order of address segments, different delimiters than decimal points or no delimiters, and fewer or more characters per address segment without departing from the principles of the invention.

[00039]   The types of services in the service set 208 are logically organized according to the networking layers (Layer 1, Layer 2, and Layer 3 service sets) typically associated with supporting the services. For example, Internet services are within the Layer 3 service set (e.g., 1x), Ethernet-LAN services (e.g., 7x) are within the Layer 2 service set, and digital and optical services (e.g., 8x and 9x, respectively) are within the Layer 1 service set. The organization according to networking layers extends to each of the address segments 204. This organization according to networking layers is merely exemplary. Other techniques for categorizing services can be used without departing from the principles of the invention.

[00040]   In more detail, each character position of the address segment 204-1 (corresponding to the service set 208) operates to distinguish the type of service (an "x" is a placeholder for any

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value). The value assigned to the most significant character in the service set 208 determines the

general type of service: e.g., an "8" value indicates a digital service, such as DS1; a "9" value

indicates an optical service. The value of the next character in the service set 208 identifies the

service type more specifically. For example, as shown in FIG. 4A, the value of the first

character identifies an instance of a type of service (here a "9" value identifies optical services

generally), and the value of the second character identifies a specific instance of an optical

service (e.g., wavelength, OC-n private line, storage private line, Ethernet private line, and

private LAN). As another example, shown in FIG. 4B, a value of "6" for the first character

identifies E-line services as a specific instance of a type of service, and the value of the second

character identifies a specific instance of an E-line service (e.g., Internet, IP Virtual Private

Network, Frame Relay, and Ethernet). Although in each of the described examples the value

assigned to each character of the structured address is numeric, it is to be understood that values

can also be alphabet characters and symbols such as #, *, and & without departing from the

principles of the invention.

[00041]   The first character of the address segment 204-2 determines the service class 212 of

the service traffic, examples of which include business class, commercial class, and best effort.

In one embodiment, the second character indicates the zone (i.e., the geographical reach) to

which the service traffic can travel. For example, six zones are defined: aggregate zone, metro

zone, regional zone, national zone, continental zone, global zone. More or fewer zones can be

defined. Zoning is described in more detail in United States Patent Application Serial No.

10/741,988, filed on December 19, 2003, and titled "Zoning for Distance Pricing and Network

Engineering in Connectionless and Connection-Oriented Networks," the entirety of which

application is incorporated by reference herein. In another embodiment, the second character of

the address segment 204-2 identifies service attributes, such as network attributes, port attributes

(e.g., 10Mbps, 100Mbps, 1000Mbps, 10/100/1000 port, etc.), and path attributes. The last

address segment 204-3 of this particular example identifies the particular service instance. In

one embodiment, each service instance corresponds to a seven-digit telephone number (i.e.,

without an area code). The seven digits for the service instance can be represented by 20 data

bits (i.e., 2^{20} different service instances).

[00042]   The service OSS 124 can use the above described address format 200 for identifying

service resources of particular interest. For example, the service OSS 124 defines service

identifiers (SIDs) that adhere to the format of the structured address 200. Consider, for example,

optical administration (layer 1) for a service ID of 93.24.5552684, defined in accordance with

the structured address format 200 of FIG. 3. This corresponds to the following service resources:

the service is Ethernet Private Line (93), the service class is Business Class PL (2), the service

reaches the National Zone (4), and the service instance is 5552684. Note that in this example,

the second character of the address segment 204-2 identifies the zone.

[00043]   As described above, the network OSS 122 can also use structured addresses for

identifying network resources. The structured address format can be the same as or different

than the exemplary structured address 200 described above for identifying optical (Layer 1)

network resources. For example, FIG. 5 shows an embodiment of a structured address format

250 including segments 254-1, 254-2, 254-3, 254-4 (generally, address segment 254), separated

by decimal points. Address segment 254-1 identifies a type of path 258, address segment 254-2

identifies the path format 262 and service zone, address segment 254-3 identifies path rate 270,

and address segment 254-4 identifies the particular numbered instance of a path. Again, the

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structured address format 250 is merely exemplary. Consider, for example, a path ID of

91.36.5.76335684. This corresponds to the following network resources: type of path is

Synchronous optical (91), the path format is framed Generic Framing Procedure or fGFP (3), the

path reach is the Global Zone (6), the path rate is STS-3c (5), and the path instance is number

76335684.

[00044]   The present invention enables inventorying of services and network resources

unattainable with conventional numbering schemes. For example, consider that the network

OSS 122 desires to know the number of DS1 ports on a particular network element. Until the

present invention, the network OSS 122 could only obtain TID/AID/channel and port ID

information from the NE, but could not correlate these numbers directly to DS1 ports. With the

present invention, DS1 ports are assigned structured addresses with a particular prefix (e.g., 83).

A search performed by the network OSS 122 for structured addresses at the NE then generates a

list of structured addresses having the particular prefix. Each structured address could then be

cross-referenced to a common name. The service OSS 124 can perform similar queries with

regards to the types of services supported by particular network elements.

[00045]   The SID and PID described in FIG. 3 and FIG 5 are examples of layer 1 addresses.

Structured addresses for service and network resources can also be implemented at the layer 2

and layer 3 networking layers. Because of the connectionless nature of such networking layers,

the structured addresses are conveyed by the packets of the service traffic, in contrast to the layer

1 addresses, which are stored at the network equipment. From these service packets, each node

or NE in the path of the service traffic can thus learn the SID and PID associated with the service

traffic.

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[00046]   A variety of techniques can be employed to convey structured packets at the layer 2

and layer 3 networking layers. For example, existing Ethernet Virtual Local Area Network

(VLAN) technology can be used to convey structured addresses. For tag-based Ethernet

VLANs, each packet has a MAC header that includes a tag, called a q-tag. Certain bits of the q-

tag identify the VLAN group membership (VLAN ID). In one embodiment, an NE can correlate

the value of these bits to a particular structured address. In another embodiment, the VLAN ID

explicitly carries a structured address. As yet another example, an NE receiving a packet can add

a field, such as a second VLAN ID, to that packet, to carry explicitly a structured address or a

value that correlates to a structured address. One skilled in the art will recognize other ways for

conveying structured addresses in the service packets, such as including the structured address in

MPLS tunnel labels and Pseudo-Wire Emulation Virtual Channel (PWE VC) labels.

[00047]   FIG. 6 illustrates an example of a layer 2 implementation for transporting structured

addresses associated with a service resource over the communications network 102. A packet

300 encapsulates an Ethernet packet 304 received from the client LAN 10 (FIG. 1). To

encapsulate the packet 304, the edge-service NE 104 prefixes source and destination address

(SA/DA) fields, a Q-tag field (collectively, 308, with the SA/DA fields), and a service ID field

312 before the header of the packet 300 and appends a frame check sequence (FCS) field 316 to

the end of the packet 300. The NE 104 adds the SID assigned to the service to the service ID

field 312. Here, for example, the SID is 64.12.5552684. From this address, the following

meaning can be determined: the type of service (ToS) is an Ethernet E-line service; the class of

the service is business class; the reach of the service is metro-zone; and the service instance is

number 5552684. Service level agreement reports sent to the service OSS 124 include the SID

among other data such as the type of service (ToS), the performance of the service (PoS), and the

availability of service (AoS). Techniques for measuring PoS and AoS metrics are described in United States Patent Application No. 10/741,296, filed on December 19, 2003, and titled "Service Metrics for Managing Services Transported over Circuit-Oriented and Connectionless Networks," the entirety of which application is incorporated by reference herein.

[00048]   FIG. 7 illustrates an example of a layer 2 implementation for transporting a structured address associated with a network resource over the communications network 102. A packet 350 encapsulates an Ethernet packet 354 received from the client LAN 10 by prefixing source and destination address (SA/DA) fields 358, a network resource ID field 362, and a Virtual Private Network (VPN) ID field 366 at the header of the packet 354 and by appending a frame check sequence (FCS) field 370 to the end of the packet 354. A structured address assigned to network resource is stored in the network resource ID field 362. For example, in FIG. 7, a structured address value of 412 is associated with a type of trunk: the value of 4 in the first character position indicates the trunk type is for an Ethernet E-Line service; the value of 1 in the second character position indicates that the service class is business class, and the value of 2 in the third character position indicates that the reach of the service is the metro-zone. As described above, a variety of techniques can be used to implement the network resource ID field 362 including an MPLS label and VLAN ID. Facility reports sent to the network OSS 124 include the trunk ID taken from the packet 350, among other data such as the type of network (ToN), the performance of the network (PoN), and the availability of network (AoN). Other identifiers, such as the network element ID (NEID), port ID (AID) and trunk ID can also be included in such facility reports.

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[00049]   While the invention has been shown and described with reference to specific

preferred embodiments, it should be understood by those skilled in the art that various changes in

form and detail may be made therein without departing from the spirit and scope of the invention

as defined by the following claims.

[00050]   What is claimed is: